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## Interdisciplinary Scientist Participation in the Phobos Mission

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The objectives of this research included study of the character and origin of Phobos' grooves and impact craters, the character and origin of noncrater surface units, the internal structure and layering, and regolith properties and the evolution of surface materials, using data from FREGAT, KRFM-ISM, TERMOSKAN, GRUNT, LIMA-D, and the landers, through participation in planning and data acquisition, and initial analysis of data through participation in individual team activities.

A secondary objective was the analysis of remote sensing data for the surface of Mars for the study of the composition and layering of the Martian crust and previously mapped geologic units.

The mission objectives were to navigate a sequence of orbits around Mars, rendezvous with Phobos and emplace landers, and to study Mars and Phobos using remote sensing.

The remote sensing objectives included measuring the UV-NIR reflectance with a spectrometer, in order to distinguish major rock-forming minerals, and to measure the thermal IR radiation with a radiometer to determine the brightness temperature, which is a function of albedo and thermal inertia determined by density, porosity and particle size.

Following is a summary of research studies and accomplishments:

Phobos is a small asteroid-like body (19 x 21 x 27 km) with low albedo (~7%) and thought to consist of carbonaceous chondrite or optically darkened mafic material. The surface is thought to be nearly uniform physically and spectrally and well-mixed by impacts.

The planet Mars is intermediate in size compared to the Moon and Earth, with a radius of 3393 kilometers. There are heavily cratered highlands in the south, with less cratered lowland plains in the north. It contains large volcanic constructs and widespread volcanic plains, and a global dust cover.

The high-resolution remote sensing instruments on Phobos 2 included the VSK (2 wide-angle visible-NIR TV cameras at 0.4 to 0.6  $\mu\text{m}$  and 0.8 to 1.1  $\mu\text{m}$ ) and a narrow-angle TV camera), KRFM (10-band UV-visible spectrometer at 0.3 to 0.6  $\mu\text{m}$  and a 6-band radiometer at 5-50  $\mu\text{m}$ ), ISM (a 128-channel NIR imaging spectrometer at 0.8 to 3  $\mu\text{m}$ ), and TERMOSKAN (a visible-NIR camera at 0.5 to 1.1  $\mu\text{m}$  and an imaging radiometer at 8 to 14  $\mu\text{m}$ ).

The data acquired from VSK included 37 images of Phobos (12 at high-resolution), complementary coverage to Viking and multi-color coverage of 60% of the satellite. That from KRFM included 2 1-kilometer resolution groundtracks on Phobos and 11 30-kilometer resolution groundtracks in Mars' equatorial region. ISM products included 2 700-meter resolution images of parts of Phobos, 2 3-kilometer resolution images of the Tharsis area of Mars, and 9 20-kilometer resolution images of Martian cratered highlands, lowland plains, volcanic plains and constructs.

These data provided improved mapping coverage of Phobos, improved mass, shape, and volume determinations, with the density shown to be lower than that of all known meteorites, suggesting a porous interior, evidence for a physically, spectrally and possibly compositionally heterogeneous surface, and showed that the spectral properties do not closely resemble those of unaltered carbonaceous chondrites, but show more resemblance to the spectra of altered mafic material.

For Mars, the data show that the underlying rock type can be distinguished through the global dust cover, that the spectral properties and possibly composition vary laterally between and within the geologic provinces, that the surface physical properties vary laterally, and in many cases the boundaries coincide with those of the geologic units, and the data acquired also demonstrate the value of reflectance spectroscopy and radiometry to the study of Martian geology.

These findings and accomplishments are documented in the attached list of publications.

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